REMARKS

This Amendment is being filed in response to an Office Action mailed on March 4, 2002. Applicants respectfully request reconsideration of the present application in light of the Amendments above and remarks below.

By this Amendment, Applicant has amended the claims, specifically, Applicant has amended claims 40-47, 49-59, 61-64, 71, 74 and 75, and Applicant has added new claims 80-87. Consequently, claims 40-87 remain in the present application. The nature of these amendments is to clarify the wording thereof in an effort to conform the interpretation to Applicant's intent. Thus, the amendment should not be understood to be a narrowing of the statement of the invention, nor an abandonment of any subject matter not originally claimed. Applicant asserts that no new matter is added by this amendment.

Prior to addressing the rejections, Applicant takes this opportunity to set forth the following brief remarks in connection with the invention, which relates to a catalyst and methods of making the catalyst.

One of the important characteristics of catalysts in accordance with preferred embodiments of the invention in the presence of "stable oxygen defects". One advantage to catalysts in accordance with preferred embodiments of the invention is having catalyst activity from visible light. Methods in accordance with the invention involve plasma and vacuum treatments. Other than by their enhanced properties, catalysts in accordance with the invention can be identified and characterized by certain spectral properties.

Thus, the degree of oxygen defects can be specified by measuring the ratio from a spectral analysis, by measuring the area assigned to the 1s oxygen atom and comparing it to the

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area assigned to the 2p titanium atom. Ratios below 2 are indicative of a high oxygen defect rate and enhanced catalytic activity. (See application, page 6).

It is also important to have oxygen defect stability. To characterize this property, the application discusses measuring the ratio (O1s/Ti2p) after a week or 6 month's exposure to the air. (p. 7).

Turning now to the Office Action, the Examiner objected to the Abstract section of the Specification because the term "said" is used in lines 2 and 7. The Examiner further objected to claims 74-79 as being of improper dependent form, for failing to further limit the subject matter of a previous claim, and the Examiner objected to claim 57 due to a specific informality, namely, the phrase; "light characterized by comprising".

The Examiner rejected claims 40-79 "under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention." The Examiner bases the rejections on numerous antecedent basis and lack of clarity citations.

Turning to the rejections based on the prior art, the Examiner rejected claims 40-49 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 5,872,072 to Mouri et al. and rejected claims 50-79 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,989,648 to Phillips in view of '072 to Mouri et al. Applicant respectfully traverses each of these rejections.

In view of the amendments to the claims as well as the remarks provided herein, Applicant respectfully submits that claims 40-87 in the present application are in condition for allowance.

As to the objection to the abstract, Applicant corrected the Abstract whereby replacing the term "said" with the term --the-- in lines 2 and 7 and, thus, has obviated the Examiner's

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objection. Other formal modifications have been made as well. Applicant thus respectfully requests withdrawal of that objection.

As to the objection to claims 74-79 under 37 C.F.R. § 1.75(c), Applicant has rewritten claim 74 and 75 in independent form to more clearly define Applicant's invention and, thus, has obviated the Examiner's objection. Applicant asserts that no new matter is added by this amendment. Applicant thus respectfully requests withdrawal of that objection.

As to the objection to claim 57 due to the phrase, "light characterized by comprising" appearing to be incorrect, Applicant has replaced the phrase "light characterized by comprising" with --comprising the step of-- and, thus, has obviated the Examiner's objection. Applicant thus respectfully requests withdrawal of that objection.

Claim Rejections under 35 U.S.C. §112, Second Paragraph

As to the rejection of claim 40 as reciting the broad recitation "visible light", and the claim also reciting "at least in the wavelength region of about 400 – 600nm" Applicant has amended claim 40 to more clearly define Applicant's invention by reciting: "A catalyst having activity under irradiation of a visible light in a wavelength region from about 400 to 600 nm." Accordingly, Applicant respectfully requests withdrawal of that rejection.

As to the Examiner's rejection of claim 40 for "the wavelength region" lacking antecedent basis, Applicant's amendment to claim 40 has provided antecedent basis by first reciting "a wavelength region", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

As to the Examiner's rejection of claims 40-79 for the phrase "the irradiation" lacking antecedent basis, Applicant's amendments to independent claims 40, 44, 47, 49, 50, 53, 56, 57,

61, 74 and 75 have provided antecedent basis by first reciting "under an irradiation of a visible light", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

As to the Examiner's rejection of claim 41 for the phrase "the anatase type or the rutile type" lacking antecedent basis, Applicant's amendment to claim 41 has provided antecedent basis by first reciting "an anatase type or a rutile type", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 42 for the phrase "the primary particle size" lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant's amendment to claim 42 obviated the rejection and accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner has also rejected claim 43 for the term "those" being unclear as to what is being referred to. Applicant respectfully traverses that rejection. Applicant has amended claim 43 to more clearly define Applicant's invention by adding a second occurrence of the term "patterns", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner has also rejected claim 44 for the phrases "the peak area", "the 1s electrons", "the bonds" and "the 2p electrons" lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant also respectfully submits that certain characteristics of a substance need not be separately introduced to provide antecedent basis. Thus, it is usually not necessary to separately introduce the diameter, weight or temperature of a material before assigning a value to it, i.e., one does not ordinarily need to recite a particle having a diameter, before claiming that the particle's diameter is less than some specified value. Similarly, any

material will have x-ray spectroscopy values, just not those specified and therefore, it is not necessary to identify these separately, i.e., it is not necessary to recite that the TiO_2 catalyst has a spectral analysis before assigning values to that analysis. (See MPEP 2173.05(e)). Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 44 for the term "that assigned" being unclear as to what is being referred to. Applicant respectfully traverses that rejection. Different regions of an x-ray spectroscopy graph are caused by different interactions. Thus, one region is affected by the 1s electron of the oxygen atom and another is affected by the 2p electron of the titanium atom. Different electrons are assigned to different parts of the spectral analysis. Thus, measuring the ratios of the peaks representing the different electrons helps measure the oxygen defect characteristics of the catalyst. (See Application pages 6-7). (See MPEP 2173.05(e)). Accordingly, Applicant respectfully submits that the Examiner's rejection of claim 44 under 35 U.S.C. §112, second paragraph, is no longer tenable. Applicant thus respectfully requests withdrawal of that rejection.

The Examiner has also rejected claim 44 for the term "(O1s/Ti2p)" being unclear as to meaning and whether the limitation is part of the claimed invention. Applicant respectfully traverses that rejection. Applicant has amended claim 44 to more clearly define Applicant's invention by moving the term to after the word ratio in claim 44, line 3. O1s/Ti2p clearly represents the ratio of 1s electrons of oxygen to 2p electrons of titanium as supported by the specification at page 6, line 15 through and including page 7, line 3 as well as at page 22, line 14 through and including page 23, line 2, and as recognized by one skilled in the art. Thus, by this amendment to claim 44, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

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The Examiner has also rejected claims 45-46 for the phrase "said ratio area" lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant's amendments to claims 45-46 have more clearly defined the Applicant's invention by reciting "said peak area ratio" having antecedent basis provided by the phrase "a ratio of a peak area, O1s/Ti2p" as recited in amended claim 44, and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner has also rejected claim 47 for the phrases "the ESR", "the g value of from 2.003 to 2.004 above" and "the wavelength region" lacking antecedent basis. Applicant respectfully traverses that rejection. The designations ESR and g value are well understood designations and the material inherently has some ESR and g values. The claim specifies what these values are. Thus, whereas a method step would not need to specifically recite a material "having a temperature" before reciting what that temperature is, this catalyst is characterized by certain ESR and g values which do not add new features to the material. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 47 for the term "it" being unclear as to what is being referred to. Applicant respectfully traverses that rejection. Applicant has amended claim 47 to more clearly define applicant's invention by inter alia adding the phrase "the catalyst", and, thus, applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 48 for the term "which" being unclear as to what is being referred to. Applicant respectfully traverses that rejection, because the claim is clear as drafted. The claim further characterizes the catalyst by stating that the signal exhibiting a

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particular value is not observed on the catalyst and that this is clear from the words selected. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claims 49, 52, 55, 58 and 65-66 for the phrases "titanium oxide-zirconium oxide based" and "silicon oxide-titanium oxide based" as being unclear as to whether the limitations are listed in the alternative. Applicant respectfully traverses that rejection. Applicant asserts that the rejected claims recite proper Markush groups. Moreover, titanium oxide-zirconium oxide based complex oxides are recognized by one skilled in the art as complex oxides made of both titanium oxide and zirconium oxide, and furthermore, silicon oxide-titanium oxide based complex oxides are also recognized by one skilled in the art as complex oxides made of both silicon oxide and titanium oxide. Thus, by Applicant's argument herein, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully submits that the Examiner's rejection of claims 49, 52, 55, 58 and 65-66 under 35 U.S.C. §112 should be withdrawn.

The Examiner also rejected claims 50 and 53 for the phrase "which comprises" as being unclear as to what is being referred to. Applicant respectfully traverses that rejection. In order to advance prosecution, Applicant has accepted the Examiner's recommendation by amending claims 50 and 53 to more clearly define Applicant's invention by substituting the phrase "said method comprising" in claims 50 and 53, and, thus, Applicant has obviated the Examiner's rejection. Accordingly, applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claims 50 and 53 for the phrases "the intrusion of air" and "the treatment system" lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant's amendments to claims 50 and 53 have provided antecedent basis by reciting "an

intrusion of air" and "a treatment system", and, thus, Applicant has obviated the Examiner's rejections. Accordingly, applicant respectfully requests withdrawal of those rejections.

The Examiner also rejected claims 51 and 54 for the phrases "the vacuum degree" and "the tightly sealed system" lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant's amendments to claims 51 and 54 have provided antecedent basis by reciting "a vacuum degree" and "a tightly sealed system", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, applicant respectfully requests withdrawal of the rejection.

The Examiner also rejected claims 52, 55 and 58 as appearing to contain improper Markush groups. Applicant respectfully traverses that rejection. In order to advance prosecution, Applicant has accepted the Examiner's recommendation by amending claims 52, 55 and 58 by replacing the term [or] with the term --and-- and, thus, Applicant has obviated the Examiner's rejection. Accordingly, applicant respectfully requests withdrawal of the rejection.

The Examiner also rejected claims 53 and 56-57 for the phrase "characterized by" being unclear as to what is being referred to. Applicant respectfully traverses that rejection. Applicant has amended claims 53 and 56-57 to more clearly define applicant's invention and requests withdrawal of that rejection.

The Examiner also rejected claims 62-64 for the phrase "which was produced" being unclear as to what is being referred to. Applicant respectfully traverses that rejection. Applicant has amended claims 62-64 to more clearly define Applicant's invention by substituting the phrase --produced by the method of--, and, thus, Applicant has obviated the Examiner's rejection. Accordingly, applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 71 for the phrases "thin-film like" and sheet-like" being indefinite as to the extent to which the claimed material resembles a thin film or sheet.

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Applicant respectfully traverses that rejection. Applicant has amended claim 71 to more clearly define Applicant's invention by reciting "said catalyst is in a substantially granular, thin-film, or sheet shape" and, thus, Applicant has obviated the Examiner's rejection. "The term "substantially" is often used in conjunction with another term to describe a particular characteristic of the claimed invention. It is a broad term. *In re Nehrenberg*, 280 F.2d 161, 126 USPQ 383 (CCPA 1960). The court held that the limitation "to substantially increase the efficiency of the compound as a copper extractant" was definite in view of the general guidelines contained in the specification. *In re Mattison*, 509 F.2d 563, 184 USPQ 484 (CCPA 1975). The court held that the limitation "which produces substantially equal E and H plane illumination patterns" was definite because one of ordinary skill in the art would know what was meant by "substantially equal." *Andrew Corp. v. Gabriel Electronics*, 847 F.2d 819, 6 USPQ2d 2010 (Fed. Cir. 1988)." See M.P.E.P § 2173.05(b). Accordingly, applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 74 for the term "comprising" being unclear as to what is being referred to. Applicant respectfully traverses that rejection. In order to advance prosecution, Applicant has accepted the Examiner's recommendation and has amended claim 74 to more clearly define Applicant's invention by substituting the phrase "said method comprising", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claims 74-75 for the term "the substance to be decomposed" lacking antecedent basis and/or appearing redundant. Applicant respectfully traverses that rejection. In order to advance prosecution, Applicant has accepted the Examiner's recommendation and has amended claims 74-75 to more clearly define Applicant's invention by

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substituting the phrase "the substance", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, applicant respectfully requests withdrawal of that rejection.

Claim Rejections under 35 U.S.C. §102

The Examiner has rejected claims 40-49 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent 5,872,072 to Mouri ("Mouri"). Applicant respectfully submits that Mouri neither teaches nor suggests Applicant's invention, as recited by the claims presently in the application.

Turning now to the rejected claims, claim 40 is rejected by the Examiner under 35 U.S.C. § 102(e) as being anticipated by Mouri. Mouri discloses catalytic compositions comprising titanium oxide (see abstract and col. 5, lines 41-42), as semiconductors (see abstract), exhibiting NOx reduction (see col. 13, lines 43-44), and having activity under ultraviolet, sunlight and fluorescent wavelengths (see col. 12, lines 1-11). In contrast, claim 40, as amended, discloses a catalyst having activity under irradiation of a visible light (emphasis ours) in a wavelength region from about 400 to 600 nm, comprising titanium oxide having stable oxygen defects, and exhibiting NOx oxidation activity under the irradiation of a visible light at least in the wavelength region of from about 400 to 600 nm.

The claims are not simply to a TiO_2 catalyst, but to a special semiconductor oxide catalyst with stable oxygen defects, a phrase discussed in the specification. Applicant asserts that Mouri does not teach a catalyst having activity under irradiation of a visible light in a wavelength region from about 400 to 600 nm. Moreover, Mouri does not teach a catalyst comprising titanium oxide having stable oxygen defects. Accordingly, Applicant thus respectfully submits that claim 40 is not anticipated by Mouri et al. under 35 U.S.C. §102(e). Accordingly, Applicant requests that the Examiner withdraw the rejection to claim 40 under 35 U.S.C. § 102(e) based on Mouri et al.

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Claims 41-43 depend from claim 40, and define the invention with greater particularity. Applicant respectfully submits that Mouri does not disclose the novel features recited by claims 41-43. Nor would those features be obvious from a hypothetical combination of Mouri and any other prior art reference of record in the present application, or from a hypothetical combination of Mouri and the knowledge of a person of ordinary skill in the art. Accordingly, Applicant respectfully submits that claims 41-43 are patentable in their own right, as well as for depending from allowable claim 40. Accordingly, Applicant requests that the Examiner withdraw the rejection to claims 41-43 under 35 U.S.C. § 102(e) based on Mouri et al.

Independent claim 44 is also rejected by the Examiner under 35 U.S.C. § 102(e) as being anticipated by Mouri et al. Mouri discloses catalytic compositions comprising titanium oxide semiconductors, exhibiting NOx reduction, and having activity under ultraviolet, sunlight and fluorescent wavelengths. In contrast, claim 44, requires a catalyst having activity under irradiation of a visible light and that the catalyst comprising titanium oxide <u>having stable oxygen defects</u> (emphasis ours) and a ratio of a peak area, the ratio being defined as O1s/Ti2p and being obtained by X-ray photoelectron spectroscopy assigned to 1s electrons of oxygen participating in bonds with titanium to the peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium with the ratio being 1.99 or lower.

The Examiner has noted a concern that the functional language asserted to be critical for establishing novelty in the claimed subject matter may be an inherent characteristic of the prior art. Applicant asserts that the specification discloses otherwise. For example, the specification notes that a "catalyst according to the present invention can be obtained, for instance, by a method comprising treating an oxide semiconductor with hydrogen plasma or a plasma of a rare gas element, and the method is characterized by that the treatment is performed in a state substantially

free from the intrusion of air into the treatment system." (Specification at page 12, lines 5-10). The specification also clarifies that "The time duration of exposing the oxide semiconductor to the hydrogen plasma or the plasma of the rare gas element is properly selected depending on the quantity of oxygen defects that are introduced into the oxide semiconductor." (Specification at page 13, lines 18-22). Clearly, the stable oxygen defects of the present invention are not inherent in the oxide semiconductor or in the hydrogen plasma or in the plasma of a rare gas element. The oxygen defects are "introduced" into the oxide semiconductor by Applicant's inventive method of treating the oxide semiconductor by exposure of the hydrogen plasma or the plasma of a rare gas element in a state substantially free from the intrusion of air into the treatment system. Also, Mouri does not disclose visible light activity, which can be achieved by following these techniques. Accordingly, Applicant thus respectfully submits that claim 44 is not anticipated by Mouri et al. under 35 U.S.C. §102(e), and further respectfully submits that the Examiner's rejection of that claim in view of Mouri et al. should be withdrawn.

Claims 45-46 depend from claim 44, and define the invention with greater particularity. Applicant respectfully submits that Mouri does not disclose the novel features recited by claims 45-46. Nor would those features be obvious from a hypothetical combination of Mouri and any other prior art reference of record in the present application, or from a hypothetical combination of Mouri and the knowledge of a person of ordinary skill in the art. Accordingly, Applicant respectfully submits that claims 45-46 are patentable in their own right, as well as for depending from allowable claim 44.

Claims 47-49 are also rejected by the Examiner under 35 U.S.C. § 102(e) as being anticipated by Mouri et al. Incorporating the arguments presented above, Applicant asserts that claims 47-49 are not anticipated by Mouri et al. under 35 U.S.C. §102(e), and further respectfully

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requests that the Examiner withdraw the rejection to claims 47-49 under 35 U.S.C. § 102(e) based on Mouri et al.

In conclusion, Applicants find no teaching or suggestion of stable oxygen defects, as recited by Applicant's existing claims 40, 44, 47, 49 and 57, newly amended claims 50, 56, 61, 74 and 75, and new claims 80 and 81. Thus, Applicants respectfully submit that the Mouri patent does not disclose each and every aspect of the claimed invention either explicitly or impliedly, and further respectfully submit that the Mouri patent is not a proper 35 U.S.C. §102(e) reference. See, e.g., MPEP §706.02(a).

Claim Rejections under 35 U.S.C. §103

Claims 50-79 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,989,648 to Phillips in view of U.S. Patent No. 5,872,072 to Mouri et al. Applicant respectfully traverses this rejection, and submits the following arguments in support thereof.

As previously stated above, Mouri fails to teach that semiconductor oxides ordinarily have stable oxygen defects. Thus, the combination of Mouri and Phillips never teach the method for production of the catalyst of the present invention having stable oxygen defects.

Applicant respectfully submits that none of the references relied upon by the Examiner in rejecting the claims of the present application, considered alone or in any hypothetical combination (between and among each other or with the knowledge of a person of ordinary skill in the art), teach or suggest Applicant's invention, as recited by the claims of the present application.

Applicant respectfully requests reconsideration of the present application in view of the amendments to the claims as well as in light of the remarks provided herein.

Pages 23-29 of this Amendment, titled VERSION WITH MARKINGS TO SHOW CHANGES MADE, indicate the changes made to the Abstract and to the Claims in accordance with this Amendment.

Early and favorable consideration of the present application in view of the amendments to the claims and remarks provided herein is respectfully requested. If the Examiner is not in a position to allow all claims as presently amended, the Examiner is urged to call the undersigned attorney at 212-806-5400.

Any additional fees or charges required at this time and in connection with the present application are hereby authorized to be charged to Deposit Account No. 19-4709.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE ABSTRACT:

Please substitute the Abstract as provided below, for the Abstract currently in the present application.

The invention is directed to a ~~A~~ catalyst having activity under the irradiation of a visible light, ~~said~~ **the** catalyst being an oxide semiconductor such as an anatase type titanium dioxide, having stable oxygen defects. A method for producing a catalyst having activity under the irradiation of a visible light which comprises treating an oxide semiconductor with hydrogen plasma or with a plasma of a rare gas element, comprising performing ~~said~~ **the** treatment in a state substantially free from the intrusion of air into the treatment system **is also provided**. An article comprising a base material having the catalyst above provided on the surface thereof **and a**. ~~A~~ method for decomposing a substance, comprising bringing an object to be decomposed into contact with the catalyst above under the irradiation of a light containing at least a visible radiation **are disclosed**. A novel photocatalyst which enables use of a visible radiation is provided, as well as a method utilizing the photocatalyst for removing various substances containing an organic matter or bacteria by photodecomposition.

IN THE CLAIMS:

Please substitute claims 40-47, 49-59, 61-64, 71, 74 and 75 as provided below, for claims 40-47, 49-59, 61-64, 71, 74 and 75 currently in the present application. Please add new claims 80-87 in the present application.

40. (Amended) A catalyst having activity under **an** ~~the~~ irradiation of ~~a~~ visible light **in a wavelength region from about 400 to 600 nm,** comprising titanium dioxide having stable oxygen defects and exhibiting NOx oxidation activity under the irradiation of a visible light at least in the wavelength region of from about 400 to 600 nm.

41. (Amended) The catalyst according to claim 40, wherein said titanium dioxide component comprises titanium dioxide of ~~the~~ **an** anatase type or ~~the~~ **a** rutile type.

42. (Amended) The catalyst according to claim 40, wherein the ~~primary particle size of said~~ titanium dioxide ~~is~~ has a primary particle size of 10 nm or less in diameter.

43. (Amended) The catalyst according to Claim 40, comprising titanium dioxide that is characterized by an X-ray diffraction (XRD) pattern that is substantially free from patterns other than those **patterns** assigned to anatase type titanium dioxide.

44. (Amended) A catalyst having activity under **an** ~~the~~ irradiation of ~~a~~ visible light**, said catalyst comprising** ~~characterized in that said catalyst comprises~~ titanium dioxide having stable oxygen defects and ~~the~~ **a peak area** ratio **(O1s/Ti2p)** of ~~the~~ **a** peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen **(O1s)** participating in the bonds with titanium to ~~that~~ **the peak area obtained by X-ray photoelectron spectroscopy** assigned to the 2p electrons of titanium **(Ti2p)** ~~(O1s/Ti2p)~~ is 1.99 or lower.

45. (Amended) The catalyst according to claim 44, wherein said **peak** area ratio (O1s/Ti2p) is in a range of from 1.5 to 1.95.

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46. (Amended) The catalyst according to claim 44, wherein said **peak** area ratio (O1s/Ti2p) remains substantially constant for time durations of 1 week or longer.

47. (Amended) A catalyst having activity under an ~~the~~ irradiation of visible light, ~~characterized in that said catalyst comprises~~ **the catalyst comprising** titanium dioxide having stable oxygen defects and **yielding** ~~yields~~ a signal having a g value of from 2.003 to 2.004 in the ESR measured in darkness at 77K under vacuum, ~~provided that it yields~~ **and the catalyst also yielding** a signal higher in intensity ~~than the g value of from 2.003 to 2.004 above~~ when measured at least under the irradiation of light in the wavelength region of from 420 to 600 nm at 77K in vacuum.

49. (Amended) A catalyst having activity under **an** ~~the~~ irradiation of a visible light, characterized in that said catalyst is an oxide semiconductor having stable oxygen defects selected from the group consisting of hafnium oxide, zirconium oxide, strontium titanate, titanium oxide-zirconium oxide based complex oxides, and silicon oxide-titanium oxide based complex oxides.

50. (Amended) A method for producing a catalyst **comprising an oxide semiconductor having stable oxygen defects and** having activity under **an** ~~the~~ irradiation of a visible light, ~~which comprises~~ **said method comprising** treating **the** ~~an~~ oxide semiconductor with hydrogen plasma, characterized by performing said treatment in a state substantially free from ~~the~~ **an** intrusion of air into ~~the~~ **a** treatment system.

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51. (Amended) The method for producing a catalyst according to claim 50, wherein **said treatment is performed in a tightly sealed system and** said state substantially free from the intrusion of air into the treatment system is a state in which the vacuum degree inside the tightly sealed system takes at least 10 minutes to make a change of 1 Torr.

52. (Amended) The method for producing a catalyst according to claim 50, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, ~~or~~ **and** a silicon oxide-titanium oxide based complex oxide.

53. (Amended) A method for producing a catalyst **comprising an oxide semiconductor having stable oxygen defects and** having activity under **an** ~~the~~ irradiation of a visible light, ~~which comprises~~ **said method comprising** treating **the** ~~an~~ oxide semiconductor with a plasma of rare gas, ~~characterized by~~ **and** performing said treatment in a state substantially free from ~~the~~ **an** intrusion of air into the treatment system.

54. (Amended) The method for producing a catalyst according to claim 53, wherein said state substantially free from the intrusion of air into the treatment system is a state in which ~~the~~ **a** vacuum degree inside ~~the~~ **a** tightly sealed system takes at least 10 minutes to make a change of 1 Torr.

55. (Amended) The method for producing a catalyst according to claim 53, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide,

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zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, ~~or~~ **and** a silicon oxide-titanium oxide based complex oxide.

56. (Amended) A method for producing a catalyst **comprising an oxide semiconductor having stable oxygen defects and** having activity under ~~the~~ **an** irradiation of visible light, ~~characterized by~~ **comprising the step of** introducing ions of a rare gas on at least a portion of the surface of **the** ~~an~~ oxide semiconductor by means of ion implantation.

57. (Amended) A method for producing a catalyst having stable oxygen defects and activity under **an** ~~the~~ irradiation of a visible light, ~~characterized by comprising~~ **comprising the step of** heating an oxide semiconductor under vacuum.

58. (Amended) The method for producing a catalyst according to claim 57, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, ~~or~~ **and** a silicon oxide-titanium oxide based complex oxide.

59. (Amended) The method for producing a catalyst according to Claim ~~53~~**50**, wherein said oxide semiconductor is an anatase type titanium dioxide.

61. (Amended) A method for producing a catalyst **comprising an anatase type titanium dioxide having stable oxygen defects and** having activity under **an** ~~the~~ irradiation of a visible light, characterized by heating **the** ~~an~~ anatase type titanium dioxide at a temperature of about 400° C or higher under a vacuum of about 1 Torr or lower.

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62. A catalyst **produced by the method of Claim 50 and** having activity under the irradiation of a visible light~~, which was produced by the method of Claim 50~~.

63. A catalyst **produced by the method of Claim 53 and** having activity under the irradiation of a visible light~~, which was produced by the method of Claim 53~~.

64. A catalyst **produced by the method of Claim 57 and** having activity under the irradiation of a visible light~~, which was produced by the method of Claim 57~~.

71. (Amended) The catalyst according to claim 40, wherein said catalyst is in a **substantially** granular, ~~a~~ thin-film ~~like~~, or ~~a~~ sheet ~~like~~ shape.

74. (Amended) ~~The~~**A** method of ~~claim 50, further~~ **effecting the** ~~including the steps of~~ photo ~~decomposing~~**decomposition of** a substance, **said method** comprising decomposing the substance ~~to be decomposed~~ by**,** ~~bringing~~ under **an** ~~the~~ irradiation of a light containing a visible radiation, **bringing** a medium containing the substance to be decomposed into contact with ~~the~~**a** catalyst **comprising titanium dioxide having stable oxygen defects and exhibiting NOx oxidation activity under the irradiation of a visible light at least in the wavelength region of from about 400 nm to 600 nm**.

75. (Amended) ~~The~~**A** method of **effecting the** ~~claim 53, further including the steps of~~ photo ~~decomposing~~**decomposition of** a substance~~,~~ comprising decomposing the substance ~~to be decomposed~~ by**,** ~~bringing,~~ under **an** ~~the~~ irradiation of a light containing a visible radiation, **bringing** a medium containing the substance to be decomposed into contact with ~~the~~**a** catalyst **comprising titanium dioxide having stable oxygen defects and the ratio of the peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen**

participating in the bonds with titanium to the peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (O1s/Ti2p) is 1.99 or lower.

80. (New) A method of effecting the photo decomposition of a substance comprising decomposing the substance to be decomposed by, under irradiation of a light containing a visible radiation, bringing a medium containing the substance to be decomposed into contact with a catalyst comprising titanium dioxide having stable oxygen defects and yields a signal having a g value of from 2.003 to 2.004 in the ESR measured in darkness at 77K under vacuum, provided that the catalyst yields a signal higher in intensity than the g value of from 2.003 to 2.004 above when measured at least under the irradiation of light in the wavelength region of from 420 to 600 nm at 77K in vacuum.

81. (New) A method of effecting the photo decomposition of a substance comprising decomposing the substance to be decomposed by, under irradiation of a light containing a visible radiation, bringing a medium containing the substance to be decomposed into contact with a catalyst comprising an oxide semiconductor having stable oxygen defects and said oxide semiconductor is hafnium oxide, zirconium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide.

82. (New) The method according to Claim 80, wherein said substance to be decomposed is at least one substance selected from the group consisting of inorganic compounds, organic compounds, microorganisms, and tumor cells.

83. (New) The method according to Claim 81, wherein said substance to be decomposed is at least one substance selected from the group consisting of inorganic compounds, organic compounds, microorganisms, and tumor cells.

84. (New) The method according to Claim 80, wherein said medium is water.

85. (New) The method according to Claim 80, wherein said medium is air.

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86. (New) The method according to Claim 81, wherein said medium is water.

87. (New) The method according to Claim 81, wherein said medium is air.

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